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(54) Pressure diecasting under the
action of gaseous pressure medium

(57) Communication between a
casting mould defined by dies (1 and
2) and an injection chamber (3) is
blocked by means of a blocking device
(8) which is applied against a seating
(31) provided on a runner bush (6)
arranged in the fixed die (2) and
communicating with the injection
chamber (3). During this blocking
phase, by opening a valve (27),
gaseous pressure medium is
introduced into the casting mould up
to a predetermined pressure when the
valve (27) closes, and the injection
chamber (3) is charged with molten
casting material from the pourer (18).
Thereafter, communication is

established between the injection
chamber (3) and the casting mould,
and the charge of molten material is
injected from the injection chamber
into the casting mould, whilst
maintaining substantially the
predetermined pressure of the
gaseous pressure medium in the
casting mould.

After the pourer (18) has charged
the injection chamber with molten
material, it is moved into a sealed
chamber (17) which surrounds the
pourer (18) and the inlet to the
chamber (3) from the pourer (18) in
sealed manner. The gaseous pressure
in the casting mould is stabilised,
during the injection phase, by bringing
the sealed chamber (17) into
communication with the casting
mould by opening a valve (28).

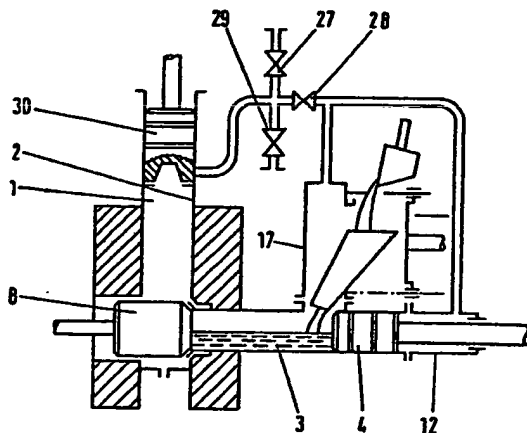


FIG. 1

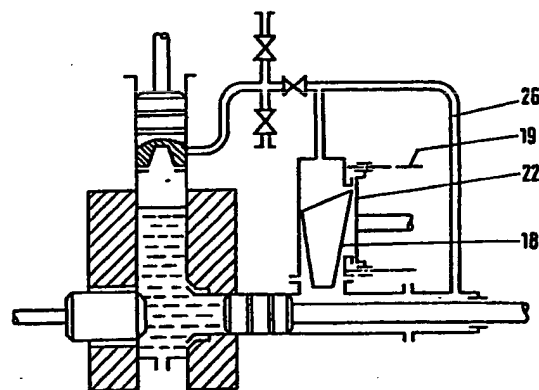


FIG. 2

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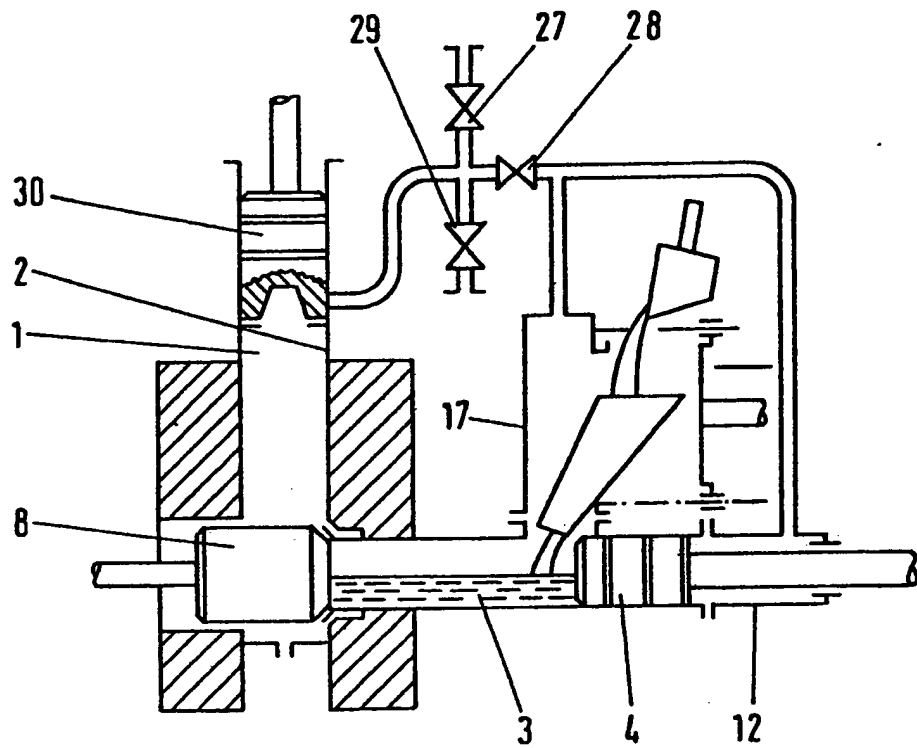


FIG. 1

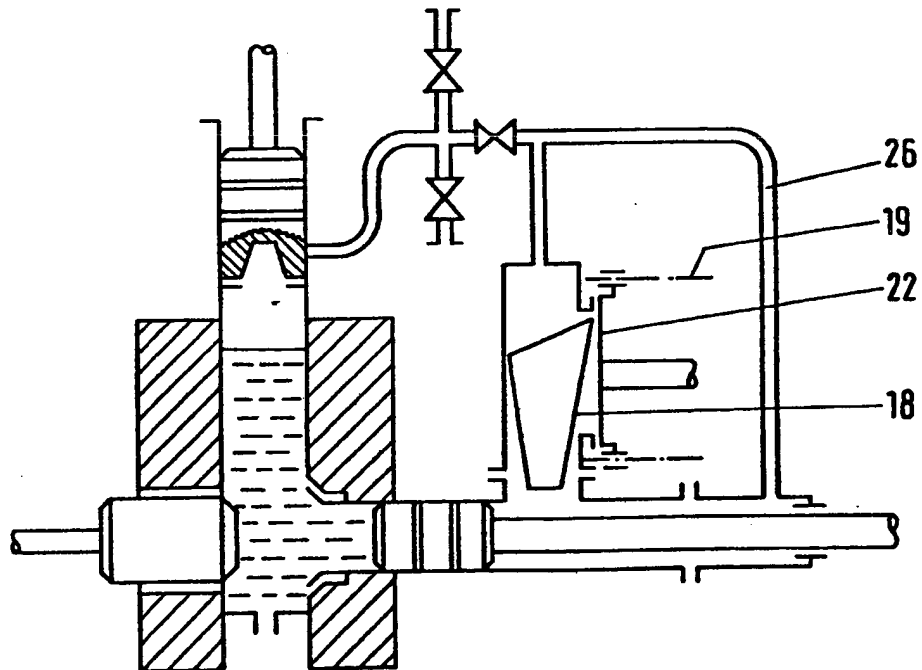


FIG. 2

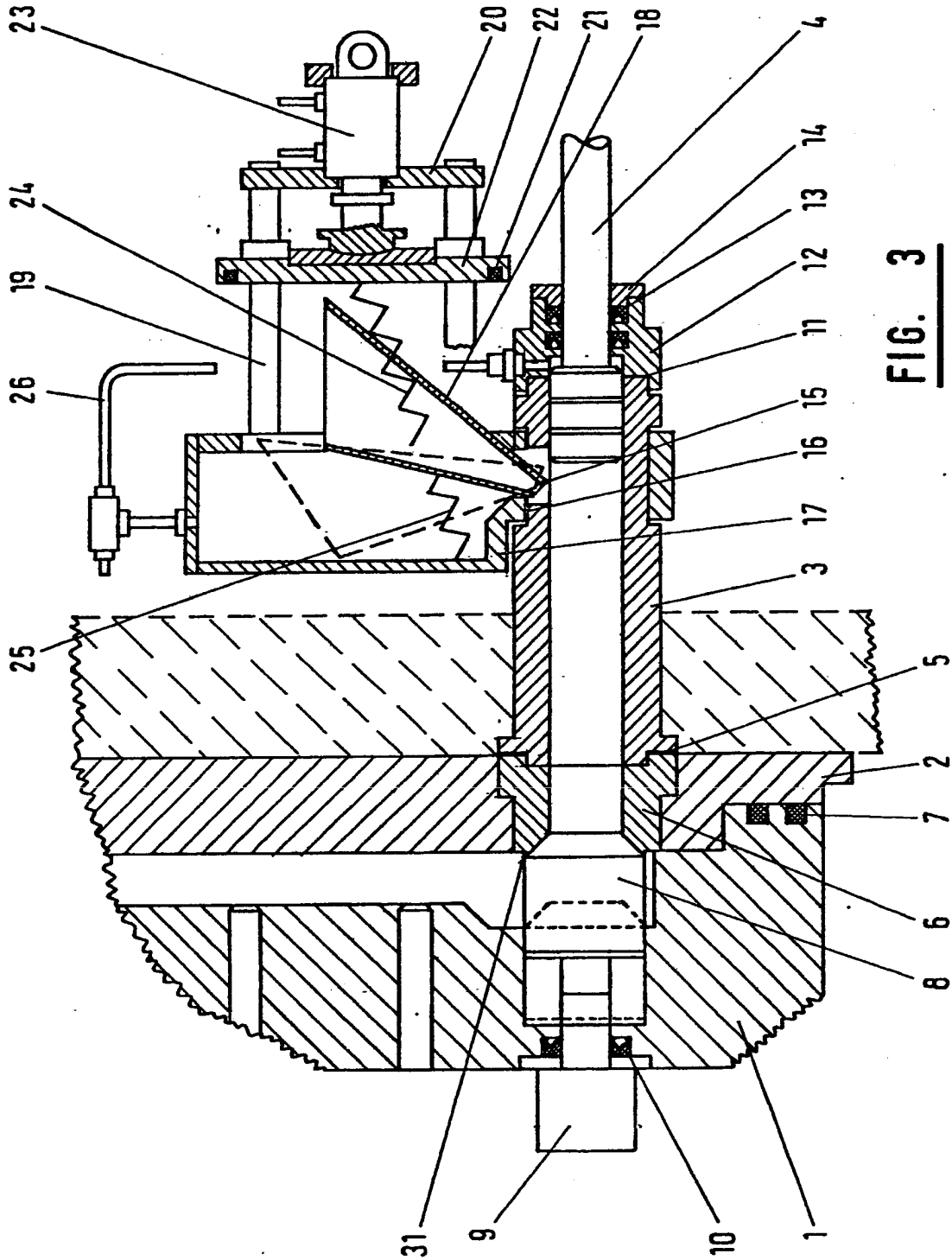


FIG. 3

SPECIFICATION

Die casting method and apparatus under the action of gaseous pressure medium

This invention relates to a method and apparatus for pressure die casting under the action of a gaseous pressure medium, using a casting apparatus having a casting mould and a pressure die casting machine having an injection chamber arranged to receive a charge of molten casting material, such as non-ferrous metals, alloys and silicate materials, and to inject the charge under pressure into the casting mould when the latter has been filled with a gaseous pressure medium.

In a known pressure die casting method, a gas counter-pressure is produced during the filling of the casting mould with molten material, the flow of the latter being laminar or nearly laminar. After the filling of the mould, the solidification of a cast body from the molten material takes place under the action of a two-sided pressure within the limits of 15 to 25 MPa.

A drawback of this method lies in that the production of the gas counter-pressure in the cavity of the casting mould, during the filling of the latter, leads to the action of a gas counter-pressure of varying magnitude — from zero to a preset final pressure — on the front of the incoming molten material. The result of this is that, regardless of the rate of production of this gas pressure, the thermal and physical conditions of filling the different zones of the casting mould and the conditions of initial solidification, taking place on the mould cavity walls which are in contact with the molten material, are different. All this has a negative effect on the quality of the cast bodies formed from the molten material.

A known apparatus to carry out this method comprises a movable and a fixed die, which are attached to the movable and to the fixed platens respectively of a piston die casting machine with a horizontal injection chamber. The fixed die is connected to the horizontal injection chamber, the chamber being provided with an inlet hole for pouring in the molten material. In the movable die there are provided ejectors for ejecting the cast body after solidification of the molten material. Also, a hole is machined in the movable die for a feeder head carrier which is fastened to a vertical hydraulic cylinder, itself rigidly attached to the movable die. The ejectors are sealed in the movable die, which in working conditions is sealed in the fixed die by means of a pack of O-rings. In the fixed die, there is provided a runner bush which is sealed towards the frontal face of the horizontal injection chamber. A piston rod operating the piston of the injection chamber is sealed by a clamp in a carrier. The space in the injection chamber behind the delivery head of the injection piston, the working cavity of the mould, the internal space of the feeder head and the space ahead of the injection piston are all interconnected by a gas conduit.

The drawbacks of this known apparatus are as

follows:

(1) in order to produce quickly a gas counter-pressure, the movable carrier of the feeder head is positioned, during the filling of the casting mould, at a preset distance from its final position, and is moved to the final position only at the end of the filling process. This requires a device to follow the reached level of the moving front of the molten material, and safety precautions against damage in case this device does not work;

(2) the impact sealing, metal-against-metal, of the carrier in a special seat in both die halves results in fast wearing of the contacting surfaces. This requires frequent reconditioning of the vents.

The present invention has been developed primarily, though not exclusively, with a view to provide a pneumo-piston (pressure die casting) method and apparatus for casting metals and other materials, in which the production of a gas pressure in the working cavity of the casting mould is independent of the flow of the molten casting material, and the sealing of the entrance of the molten material to the injection chamber does not require the provision of a seal immediately adjacent to a charging inlet to the injection chamber which could have an adverse influence on the sealing of the injection chamber during the injection process.

According to one aspect of the invention there is provided a method of pressure die casting under the action of a gaseous pressure medium, using a casting apparatus having a casting mould and injection chamber arranged to receive a charge of molten casting material and to inject the charge under pressure into the casting mould when the latter has been filled with gaseous pressure medium which acts upon the incoming charge of molten material and which applies two-sided pressure action on the material as it solidifies in the casting mould, comprising the following steps:

Initially blocking communication between the casting mould and the injection chamber; introducing gaseous pressure medium to the casting mould up to a predetermined pressure; charging the injection chamber with a charge of molten casting material;

and establishing communication between the injection chamber and the casting mould and injecting the charge of molten material from the injection chamber into the casting mould, while maintaining substantially the predetermined pressure of the gaseous pressure medium in the casting mould.

According to a further aspect of the invention there is provided pressure die casting apparatus for casting molten material under the action of gaseous pressure medium and comprising:

a movable die and a fixed die which define a casting mould and which are attached respectively to a movable platen and to the fixed platen of a piston pressure diecasting machine;

a piston operated injection chamber arranged in the die casting machine to receive a charge of molten casting material and to inject the charge into the casting mould when the latter has been

filled with gaseous pressure medium;

a charging inlet formed in the wall of the injection chamber, and a pourer arranged to charge the chamber with molten material via the inlet;

a runner bush mounted in the fixed die and communicating with the injection chamber;

a blocking device carried by the movable die and movable relative to the die towards and away from blocking engagement with a seating in the runner bush in order respectively to block and to allow communication between the injection chamber and the casting mould;

a sealable chamber surrounding the inlet to the injection chamber, the pourer being movable into the sealable chamber after it has discharged molten material into the injection chamber;

a sealing device arranged to close the sealable chamber after the pourer has moved into the latter;

means for filling the casting mould with gaseous medium at a predetermined pressure while the blocking device is against the seating of the runner bush;

and means for communicating the gaseous pressure medium in the casting mould with the sealable chamber when the pourer has moved into the sealable chamber and the piston of the injection chamber has commenced injection of a charge of molten material into the casting mould.

In a method in accordance with the invention, the gas pressure is produced in the working cavity of the casting mould, regardless of the process of pouring-in of the molten material into the injection chamber. Thus, during the pressure-injection filling of the casting mould, there acts on the front of the flowing molten material, at any instant, a gas pressure of constant magnitude. This provides substantially equalised conditions during the course of initial solidification of the material along the walls of the mould cavity, which provides favourable possibilities for the compensation of the volumetric reduction upon solidification, thereby to achieve a suitable macro structure (micro structure) and improved physical and mechanical properties of the castings obtained in the method.

The method also permits the use of gaseous mixture of different compositions, to act on the molten material, during pouring-in into the injection chamber and during the subsequent charging of the casting mould. This increases the positive effect of gas alloying, when required.

In an embodiment of apparatus according to the invention, the blocking device is horizontally movable towards and away from blocking engagement with the seating in the runner bush, and this enables the sealing of the working cavity of the casting mould and of the space of the injection chamber separately and independently from one another. As a result of this, the gas pressure is produced simultaneously with the pouring-in of the molten material into the injection chamber. Furthermore, preferably there is a vertically movable carrier of the feeder head which comes

smoothly and impact-free to its end position, so that the contacting metal surfaces are not damaged and the necessary vents, machined in them, retain their shape.

The apparatus does not require a device to follow the motion of the feeder head to its end position depending on the position of the front of the incoming molten material, neither does it require a safety device which would be required as a safeguard against failure of the following device.

The inlet to the injection chamber in the apparatus does not require its own individual sealing device, following charging of molten material therethrough, and the sealing of the injection chamber, during the injection process, is therefore not dependent upon the quality of the seal which might otherwise be provided at the inlet. Accordingly, there is avoided the danger of poor sealing which might result when drops and splashed of molten material fall around the inlet during pouring of molten material from the pourer into the chamber. This also avoids danger of violation of conditions of casting, necessary for the removal of such drops and splashes.

One embodiment of apparatus for carrying out the method of the invention will now be described in more detail, by way of example only, with reference to the accompanying drawings in which:—

Figure 1 is a diagrammatic illustration of a pressure die casting apparatus, during charging of molten material into a horizontal injection chamber and the simultaneous generation of gas pressure within a casting mould of the apparatus;

Figure 2 is a diagrammatic illustration of the apparatus during charging of the casting mould with material from the injection chamber; and

Figure 3 is a longitudinal cross-sectional view, to an enlarged scale, of a portion of the casting mould and the injection chamber.

Referring now to the drawings, the apparatus comprises a movable die 1 and a fixed die 2 which together define a casting mould, and which are attached to the movable and to the fixed vertical platens respectively of a piston pressure die casting machine having a horizontal injection chamber 3. In the chamber 3 there is provided an injection piston 4 driven by a piston rod in order to carry out injection of a charge of molten material into the casting mould. The fixed die 2 is connected to the horizontal injection chamber 3, and sealing between them is effected by means of a large flat gasket 5 positioned between a runner bush 6 mounted in the fixed die 2 and the front part of the horizontal injection chamber 3. The runner bush 6 communicates with the chamber 3, but its mouth, which communicates with the casting mould, is capable of being blocked by means of a horizontally movable blocking device 8 driven by an hydraulic cylinder 9 attached rigidly to the movable die 1.

In a working position, the movable die 1 is sealed in the fixed die 2 by means of a pack of O-rings 7. The blocking device 8 is carried by the movable die 1, and is movable relative to the die

towards and away from blocking engagement with a seating 31 at the mouth of the runner bush 6 in order respectively to block and to allow communication between the injection chamber 3 and the casting mould. As indicated above, the blocking device 8 is operated by a horizontal hydraulic cylinder 9, the piston rod of which is sealed in the movable die 1 by means of K-type sealing rings 10.

The rear end of the injection chamber 3 is sealed frontally by a small flat gasket 11 in a carrier 12, in which the piston rod of the injection piston 4 is sealed by means of a pack of K-type sealing rings 13 and a clamp 14.

An inlet hole 15 is formed in the wall of the injection chamber 3, and the lower discharge end of a pourer 18 communicates with the hole 15 in order that a charge of molten material can fill the chamber 3, when desired. There is no necessity to provide a sealing device immediately adjacent to the inlet hole 15, since a sealable chamber 17 is provided which is fastened rigidly to the wall of the chamber 3 and surrounds the inlet hole 15. The chamber 17 is formed by a semi-cylinder, and serves also to receive the pourer 18 after the latter has been moved therein, following charging of molten material into the chamber 3.

The pourer or spout 18 is mounted in the chamber 7 for pivotal movement about a horizontal axis. Horizontal guiding columns 19 are fastened rigidly to an end wall of the chamber 17, and a carrying plate 20 is fastened rigidly to the columns 19 at their ends remote from the chamber 17. An opening is formed in the same end wall of the chamber 17 which allows movement of the pourer 18 into and out of the chamber 17, this hole being surrounded by an O-ring 21 arranged in a groove formed in a movable sealing plate 22, mounted on the columns 19. The movable sealing plate 22 is connected to a horizontal cylinder 23 which reacts from the carrier plate 20 in order to move the sealing plate 22 towards and away from sealing engagement with the chamber 17.

The pourer 18 is connected by springs 24 to the movable sealing plate 22, and by means of a spring 25 to the wall of the chamber 17.

An arrangement of pipework 26 is provided to convey gaseous pressure medium around the apparatus, and has a first electromagnetic valve 27 which is openable to admit a gas pressure supply from a pressure source (not shown), and a third electromagnetic valve 29 for connecting the pipework 26 to atmosphere. The pipework 26 includes a branch which leads to the movable die 1 i.e. to the casting mould, and opening of valve 27 allows the casting mould to be charged with gaseous pressure medium to any predetermined pressure. Opening of valve 29 allows the gaseous pressure medium to be vented to atmosphere. A second electromagnetic valve 28 is provided to control the communication between the gaseous pressure medium in the casting mould with further branches of the pipework 26 which lead to the sealed chamber

17, and also to the space in the chamber 3 behind the delivery head of the piston 4.

The operation of the apparatus is as follows.

Upon closure of the casting mould, it is sealed by operation of cylinder 9 which pushes the blocking device 8 into sealing metal-to-metal contact with the seating 31 of the runner bush 6. The second valve 28 and the third valve 29 are closed, and the first valve 27 is opened, which connects the source of pressurised gas to the working cavity of the casting mould defined between the dies 1 and 2. When a preset pressure P_1 is reached, the first valve 27 is closed, and the feeder head carrier 30 is moved by a vertical hydraulic cylinder (not shown) smoothly downwards until it makes sealing metal-against-metal contact in a seat formed by the movable die 1 and the fixed die 2.

Simultaneously with the production of the pressure P_1 in the casting mould, a charge of molten material is poured through the pourer 18 into the horizontal injection chamber 3 via the inlet hole 15. The space in the chamber 3 in front of the piston 4, and also in the chamber 17 which seals the inlet hole 15 when the pourer 18 has been moved therein and the sealing plate 22 moved to close the chamber 17, is equal to the ambient atmospheric pressure P_0 .

After the pouring-in of the required quantity of molten material, the inlet hole 15 is sealed, in that the chamber 17 which surrounds the inlet hole 15 is sealed, following movement of the pourer 18 into the chamber 17 and the closing of the chamber 17 by the plate 22. The pourer 18 moves to its position within the chamber 17, as shown in Figure 2, by pivoting about its horizontal axis. At the moment when the pourer 18 has moved to its non-operational position inside the chamber 17 (but before complete sealing of the chamber 17), a command signal is issued which initiates the injection stroke of the piston 4. After the sealing of the chamber 17 has been completed, a further two command signals are issued, a first to cause opening of the second valve 28 which communicates the gaseous pressure medium in the working cavity of the casting mould (at pressure P_1) with the space in the chamber 3 behind the piston 4. The second command signal causes motion of the blocking device 8 away from the runner bush 6, as shown in Figure 2, so that the molten material can be injected by the piston 4 into the casting mould.

The arrangement of the pipework 26 is such that pressure stabilisation can be achieved within the casting mould during the injection phase of molten material from the chamber 3 into the casting mould.

During, and after the solidification of a cast body in the casting mould from the molten material, as a result of the natural shrinkage of this material e.g. an alloy, there is formed a clearance between the walls of the casting mould and the cast body. Accordingly, a communication is established between the gas compressed in the feeder head via the venting conduits, and the gas

in the common gas pipe work or conduit 26. Thus, two-sided pressure action is applied to the cast body during solidification. By opening the third valve 29, the pressure inside the entire system reverts to atmospheric pressure. This then triggers a signal for the return travel of the feeder head carrier 30 and of the movable sealing plate 22 by the respective hydraulically operated cylinders. There then follows a command for the opening of the casting mould, and operation of an injection mechanism (not shown) of the piston operated die casting machine. This ejects the cast body from the movable die 1.

After carrying out further necessary

preparations to the apparatus, the casting mould is closed and a successive cycle of casting operations can be carried out.

CLAIMS

1. A method of pressure die casting under the action of a gaseous pressure medium, using a casting apparatus having a casting mould and an injection chamber arranged to receive a charge of molten casting material and to inject the charge under pressure into the casting mould when the latter has been filled with gaseous pressure medium which acts upon the incoming charge of molten material and which applies two-sided pressure action on the material as it solidifies in the casting mould, comprising the following steps:

- initially blocking communication between the casting mould and the injection chamber;
- introducing gaseous pressure medium to the casting mould up to a predetermined pressure;
- charging the injection chamber with a charge of molten casting material;
- and establishing communication between the injection chamber and the casting mould and injecting the charge of molten material from the injection chamber into the casting mould, while maintaining substantially the predetermined pressure of the gaseous pressure medium in the casting mould.

2. A method according to claim 1, in which the casting mould comprises a fixed die and a vertically movable die, and the injection chamber has an horizontally movable piston for injecting the charge of molten material into the casting mould defined between the fixed die and the movable die.

3. A method according to claim 1 or 2, in which the gaseous pressure medium applies two-sided pressure within the range 15 to 25 MPa onto the molten material as it solidifies in the casting mould.

4. A method according to any one of the preceding claims, in which the molten material is charged into the injection chamber via a movable pourer which has a discharge outlet communicating with the chamber via an inlet in the wall of the chamber, the pourer being moved to a position inside a chamber which thereafter surrounds the pourer and the inlet to the injection chamber in sealed manner, after the charge of molten material has been discharged from the

pourer.

5. Pressure die casting apparatus for casting molten material under the action of a gaseous pressure medium and comprising:

a movable die and a fixed die which define a casting mould and which are attached respectively to a movable platen and to the fixed platen of a piston pressure diecasting machine;

a piston operated injection chamber arranged in the diecasting machine to receive a charge of molten casting material and to inject the charge into the casting mould when the latter has been filled with gaseous pressure medium;

a charging inlet formed in the wall of the injection chamber, and a pourer arranged to charge the chamber with molten material via the inlet;

a runner bush mounted in the fixed die and communicating with the injection chamber;

a blocking device carried by the movable die and movable relative to the die towards and away from blocking engagement with a seating in the runner bush in order respectively to block and to allow communication between the injection chamber and the casting mould;

a sealable chamber surrounding the inlet to the injection chamber, the pourer being movable into the sealable chamber after it has discharged molten material into the injection chamber;

a sealing device arranged to close the sealable chamber after the pourer has moved into the latter;

means for filling the casting mould with gaseous medium at a predetermined pressure while the blocking device is against the seating of the runner bush;

and means for communicating the gaseous pressure medium in the casting mould with the sealable chamber when the pourer has moved into the sealable chamber and the piston of the injection chamber has commenced injection of a charge of molten material into the casting mould.

6. Apparatus according to claim 5, in which the sealing device comprises a sealing plate arranged to be driven so as to move the pourer into the sealable chamber and to close the latter in sealed manner, after the pourer has discharged the molten material into the injection chamber.

7. Apparatus according to claim 5 or 6, in which a space is defined in the injection chamber behind the delivery head of the piston, and is also communicable with the gaseous pressure medium in the casting mould when the piston has commenced injection of a charge into the casting mould.

8. Apparatus according to any one of claims 5 to 7, in which the movable die is vertically movable, and the piston of the injection chamber is horizontally movable.

9. Apparatus according to any one of claims 5 to 8, including piston/cylinder devices arranged to control the movement of the movable die, the blocking device, and the sealing device.

10. A method according to claim 1 and substantially as hereinbefore described with

reference to, and as shown in the accompanying drawings.

11. Apparatus according to claim 5 and

substantially as hereinbefore described with reference to, and as shown in the accompanying drawings.

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